

This listing of claims will replace all prior versions, and listings, of claims in the application.

Listing of Claims:

1. (Currently Amended) An electromagnetic actuator comprising:
a housing defining a cavity therein;
a solenoid coil disposed in the cavity of the housing;
an armature disposed substantially coaxially with the solenoid coil, wherein the armature can move between a first position proximate a portion of the housing and a second position distal of the portion of the housing, in the second position the armature and the portion of the housing define a first gap therebetween;
an extension member extending in an axial direction into the first gap and defining a second gap, the width of the second gap being less than the width of the first gap; and
a permanent magnet disposed in the housing coaxially with a central axis of the armature and coaxially with a central axis of the solenoid, the permanent magnet facing the armature, the permanent magnet and the armature being on opposite sides of the first gap, wherein the permanent magnet biases the armature towards the solenoid.
2. (Withdrawn) The electromagnetic actuator as recited in claim 1, wherein the extension member extends from the armature into the first gap.
3. (Withdrawn) The electromagnetic actuator as recited in claim 2, wherein the housing comprises a recess that receives the extension member in the first position.
4. (Original) The electromagnetic actuator as recited in claim 1, wherein the extension member extends from the housing into the first gap.
5. (Withdrawn) The electromagnetic actuator as recited in claim 4, wherein the armature comprises a recess that receives the extension member in the first position.
6. (Currently Amended) An electromagnetic actuator comprising:

a housing comprising a body and an extension member having an inner surface;
a solenoid coil disposed in the housing;
a shaft disposed substantially coaxially with the solenoid coil;
an armature having an outer surface, the armature coupled to the shaft, wherein the shaft and armature can move between a first position proximate the solenoid coil and a second position distal of the solenoid coil, in the second position the armature and the body of the housing define a first gap therebetween, the extension member extending in an axial direction towards the armature and beyond the solenoid coil such that the inner surface of the extension member and the outer surface of the armature define a second gap therebetween, the width of the second gap being less than the width of the first gap; and
a permanent magnet disposed in the housing coaxially with a central axis of the armature and coaxially with a central axis of the solenoid, the permanent magnet facing the armature, the permanent magnet and the armature being on opposite sides of the first gap, wherein the permanent magnet biases the armature towards the solenoid.

7. (Original) The electromagnetic actuator as recited in claim 6, wherein the housing does not enclose the armature.

8. (Original) The electromagnetic actuator as recited in claim 6, wherein the housing is substantially annularly shaped.

9. (Original) The electromagnetic actuator as recited in claim 8, wherein the inner surface of the extension member is substantially annularly shaped.

10. (Original) The electromagnetic actuator as recited in claim 8, wherein the solenoid coil is disposed substantially coaxially in the housing.

11. (Original) The electromagnetic actuator as recited in claim 9, wherein the armature is substantially annularly shaped.

12. (Original) The electromagnetic actuator as recited in claim 11, wherein the outer surface of the armature is substantially annularly shaped.

13. (Original) The electromagnetic actuator as recited in claim 12, wherein the armature is disposed substantially coaxial with the solenoid coil.

14. (Original) The electromagnetic actuator as recited in claim 12, wherein the second gap between the extension member and the armature is substantially annularly shaped.

15. (Original) The electromagnetic actuator as recited in claim 6, wherein the inner surface of the extension member and the outer surface of the armature are substantially parallel such that the second gap width between the extension member and the armature is substantially constant.

16. (Withdrawn) The electromagnetic actuator as recited in claim 6, wherein the inner surface of the extension member and the outer surface of the armature are not parallel such that the second gap width between the extension member and the armature increases with increasing distance from the solenoid.

17. (Withdrawn) The electromagnetic actuator as recited in claim 6, wherein the inner surface of the extension member and the outer surface of the armature are not parallel such that the second gap width between the extension member and the armature decreases with increasing distance from the solenoid.

18. (Original) The electromagnetic actuator as recited in claim 6, wherein the shaft comprises a shaft collar on an end of the shaft, the shaft collar limiting shaft travel in an axial direction.

19. (Original) The electromagnetic actuator as recited in claim 6, wherein the shaft comprises threads.

20. (Original) The electromagnetic actuator as recited in claim 9, wherein the shaft comprises a threaded nut engaged with the shaft threads, the threaded nut securing the armature to the shaft.

21. (Original) The electromagnetic actuator as recited in claim 6, wherein the armature has an annular recess for receiving a spring.

22. (Original) The electromagnetic actuator as recited in claim 6, wherein the armature has a passage and a portion of the shaft is disposed in the passage.

23. (Original) The electromagnetic actuator as recited in claim 6, further comprising a spring that biases the armature away from the solenoid.

24. (Canceled) The electromagnetic actuator as recited in claim 6, further comprising a permanent magnet disposed in the housing, wherein the permanent magnet biases the armature towards the solenoid.

25. (Currently Amended) The electromagnetic actuator as recited in claim 46, wherein the permanent magnet is substantially annularly shaped.

26. (Original) The electromagnetic actuator as recited in claim 6, further comprising a core disposed in the housing.

27. (Original) The electromagnetic actuator as recited in claim 6, further comprising a cylindrical bushing disposed in the housing and a portion of the shaft is disposed in the bushing.

28. (Original) The electromagnetic actuator as recited in claim 6, further comprising a clamp plate disposed on the housing, wherein the extension member extends in an axial direction towards the armature and beyond the clamp plate.

29. (Withdrawn) An electromagnetic actuator comprising:
a housing defining a cavity therein;
a solenoid coil disposed in the cavity of the housing;
an armature disposed substantially coaxially with the solenoid coil, wherein the
armature can move between a first position proximate a portion of the housing and a second
position distal of the portion of the housing, in the second position the armature and the
portion of the housing define a first gap therebetween; and

an extension member extending in an axial direction into the first gap and defining a
second gap, the width of the second gap being less than the width of the first gap, the
extension member extending from only a portion of the housing.

30. (New) The electromagnetic actuator as recited in claim 1, wherein the
extension member extends into the first gap from only a portion of the housing.

31. (New) The electromagnetic actuator as recited in claim 6, wherein the
extension member extends into the first gap from only a portion of the housing.